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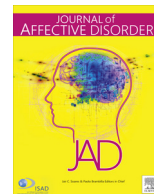
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Research paper

Uncovering key patterns in self-harm in adolescents: Sequence analysis using the Card Sort Task for Self-harm (CaTS)



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ABSTRACT

Background: Self-harm is a significant clinical issue in adolescence. There is little research on the interplay of key factors in the months, weeks, days and hours leading to self-harm. We developed the Card Sort Task for Self-harm (CaTS) to investigate the pattern of thoughts, feelings, events and behaviours leading to self-harm.

Methods: Forty-five young people (aged 13–21 years) with recent repeated self-harm completed the CaTS to describe their first ever/most recent self-harm episode. Lag sequential analysis determined significant transitions in factors leading to self-harm (presented in state transition diagrams).

Results: A significant sequential structure to the card sequences produced was observed demonstrating similarities and important differences in antecedents to first and most recent self-harm. Life-events were distal in the self-harm pathway and more heterogeneous. Of significant clinical concern was that the wish to die and hopelessness emerged as important antecedents in the most recent episode. First ever self-harm was associated with feeling better afterward, but this disappeared for the most recent episode. **Limitations:** Larger sample sizes are necessary to examine longer chains of sequences and differences in genders, age and type of self-harm. The sample was self-selected with 53% having experience of living in care.

Conclusions: The CaTS offers a systematic approach to understanding the dynamic interplay of factors that lead to self-harm in young people. It offers a method to target key points for intervention in the self-harm pathway. Crucially the factors most proximal to self-harm (negative emotions, impulsivity and access to means) are modifiable with existing clinical interventions.

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1. Introduction

Self-harm (self-poisoning or self-injury regardless of the intent associated with the act; [Hawton et al., 2007](#)) is a significant problem in adolescence which is strongly linked to death by suicide ([Hawton et al., 2012](#)). Around 40–60% of those who die by suicide have previously self-harmed meaning that their risk of suicide is hundreds of times higher than the general population ([Owens et al., 2002](#)). Suicide is the second largest cause of mortality in young people globally and so it is important to understand factors which lead to these behaviours ([Townsend, 2014](#)).

Self-harm is a complex phenomenon and is not well understood. Research indicates that it is associated with multiple psychological, social and biological factors ([Hawton et al., 2012](#); [Townsend, 2014](#)). However, the factors associated with self-destructive behaviour (Non-Suicidal Self-Injury) are commonly examined in isolation (or with a few other factors), over long time periods (commonly 12 months), which limits their predictive utility ([Fox et al., 2015](#)). Here we examine the dynamic interplay of thoughts, feelings, behaviours and events right up to the hour before self-harm. A dynamic approach to understanding the key factors associated with self-harmful behaviour has been called for in the literature ([Milner et al., 2013](#)).

In this study, we use sequence analysis, which allows us to examine which factors are most proximal to self-harm and which are more distal. It also permits systematic examination of the

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antecedents and consequences of self-harmful behaviour. In order to conduct sequence analysis on the thoughts, feelings, events and behaviours that occur prior to (and following) self-harm we developed the Card Sort Task for Self-harm (CaTS). We assess the utility of this method by comparing first ever and most recent episodes of self-harm, as reported by young people. In addition to examining the relative frequency of each item (i.e. specific thoughts, feelings, events, behaviours), we sought to identify important *sequences* of items leading to self-harm. To this end, we employed a lag sequential analysis (Bakeman and Gottman, 1997; Faraone and Dorfman, 1987). Sequential statistics examine statistical dependencies between events over time in order to identify patterns in data sequences. These methods have been used in other areas of the social and behavioural sciences, particularly in examining interpersonal interactions such as marital conflict (Gottman, 1979), work-related violence (Beale et al., 1998) and rape (Fossi et al., 2005; Lawrence et al., 2010).

One study has examined the sequential structure of Self-Injurious Behaviours (SIB) in a residential setting with 53 individuals with severe behaviour disorder/neurodevelopmental disabilities (74% with 'profound mental retardation') (DeBoard Marion et al., 2003). Such habitual, repetitive behaviours in those with severe learning disability are considered to be distinct from self-harm and are commonly excluded from studies of self-harm in general population and mental health settings (see Haw et al., 2001, for an example). In the DeBoard Marion et al. (2003) sample, for example, 45 (84%) of the participants had five instances of SIB in a 40-h observation period and conditional probability calculations showed that the best predictor of SIB was an earlier episode of SIB (and not other environmental factors), thus demonstrating the utility of a sequential APPROACH. To our knowledge, a sequential approach has not been used to examine self-harm as defined in the present study.

The card sort task we have developed is similar to chain analysis used in Dialectical behaviour therapy (DBT). Chain analysis is a form of functional behavioural analysis which aims to help individuals identify sequences of cognitions, emotions and behaviours in order to assess and modify unhelpful responses such as self-harm or suicidal thinking (Dimeff and Koerner, 2007; Linehan, 1993). Chain analysis in DBT focuses on an individual and their environment. However, the use of sequence analysis with the card sort task allows us to systematically describe significant sequences related to self-harm across individuals.

The aim of this study was to provide a novel and more nuanced description of patterns of thoughts, feelings, events and behaviours experienced prior to self-harm. Sequence analysis allows us to explore and summarise cross-dependencies occurring in the interactive sequences of factors associated with self-harm. Importantly, the CaTS allows young people to describe their own experience of self-harm which means the factors they report are the ones most salient to them personally. This is important since the perceived motivations and factors leading to self-harm are known to differ between young people and professionals (Hawton et al., 1982).

Here we asked participants to describe their first ever and most recent episode of self-harm. We felt this comparison would be important since the pathway into the first ever self-harm episode would reflect the transition from thinking about self-harm (ideation) and acting upon these thoughts (enaction). The process of behavioural enaction in self-harm and suicide is poorly understood (Klonsky and May, 2014; O'Connor et al., 2012; May and Klonsky, 2016).

The present study, therefore, will elucidate the temporal dynamics of self-harm in order to uncover key-transitions in self-harm behaviour. These findings could have important clinical applications in terms of providing a tool to help a client understand

their journey into self-harm (behavioural enaction), which factors maintain their behaviour and what may help them with recovery.

2. Method

2.1. Participants

Young people aged 11–21 years who had self-harmed in the past six months were eligible to take part in the study. Participants were recruited from Child and Adolescent Mental Health Services and Children's Social Care Services in the East Midlands and environs. They were also recruited in the community through a self-harm support organisation, secondary schools and social media thus making the study available nationally in England. Just over half of the participants had experienced residential or foster care.

Participants and (if under 16 years) carers were given information sheets, and the opportunity to ask questions, before providing informed consent. Consent from social workers was also obtained in the case of some of the looked-after young people (if under 16 and depending on the individual's statutory care placement). A comprehensive safeguarding and crisis management plan was in place. Ethical approval was obtained from the Social Care Research Ethics Committee and the School of Psychology Research Ethics Committee (University of Nottingham).

2.2. Demographic information

Participants were asked about their ethnicity, current education/employment status, age, gender and residential arrangements.

2.3. Self-harm frequency and method

To determine the frequency of self-harm participants were asked an open-ended question about the number of times they had self-harmed. Methods used were investigated through a checklist adapted from Gratz (2001).

2.4. Card Sort Task for Self-harm (CaTS)

The participants were given a set of 117 cards with thoughts, feelings, events, behaviours and self-harm supports/services printed on them. Seven cards relevant to after the self-harm episode ("afterwards") were also included. The full list of the CaTS items is provided in the supplementary material (Table S1). Example items include "I was not afraid of death", "I felt trapped", "I was a victim of a crime", "I was drunk", "I phoned a helpline which helped", and "I felt worse after self-harm". Items were drawn from self-harm research literature, and key contemporary theory and models. We included items from Williams (1997) Cry of Pain Theory (eg. entrapment – "I felt trapped") and O'Connor's (2011) Integrated Motivational Volitional Model (eg. future thoughts – "I felt very hopeless about the future") and life events ("I had an argument with my boyfriend/girlfriend"). From Joiner's (2005) Interpersonal Theory we included acquired capability ("I was not afraid of death"), burdensomeness ("I felt like a burden on people") and belonging. Items were also selected from recent observational and prospective studies of self-harm and suicidality in young people. For example, from O'Connor et al. (2012) we included exposure to self-harm in others "I knew someone who was self-harming" and from Glazebrook et al. (2015) attachment issues – "I was rejected by my parents".

The items were reviewed in consultation with the multi-disciplinary research team comprised of experienced academics and clinicians in the field. They helped to generate the list of

services and supports eg. “I received therapy which helped”. We then discussed the items with an advisory group of young people with first-hand experience of self-harm who added some items such as “I moved to a different school”. Finally, participants themselves had the option to add items if required and 11 cards were added during the study eg. “I talked to a boyfriend/girlfriend which helped”. Cards were broadly grouped into the categories of “thoughts”, “feelings”, “events”, “behaviours” and “supports and services”. This was done for the sole purpose of presenting the cards to participants in manageable sets of smaller numbers and thus the categories should not be regarded as superordinate factors representing a model of the items.

Participants were asked to think about two specific self-harm incidents (first episode and then most recent episode) and to look through all the cards and ‘select cards describing items (things) that *you think* were definitely important or significant in the six months leading up to that episode of self-harm’ and to place them along the time line in the order in which they occurred. Participants were told that they could use as many or as few cards as they wanted but that the cards must be placed in a sequence (in order) across the timeline. The researcher remained in the room while the participants completed the task and answered any questions, such as clarifying what the meanings of certain cards were. Time stamp cards were provided (6 months before, 1 month before, 1 week before, 1 day before, 1 h before, self-harm, afterwards) to allow participants to arrange the cards in a sequence along a 6 month timeline. The cards were presented in their categories but in a shuffled order within each category. The participants completed CaTS in relation to their first episode of self-harm and then their most recent episode. The mean length of time spent completing the card sort task was 21.00 min (SD=7.44), with a range of 5–40 min. Once completed a photograph of the card sequences was taken (see Fig. 1 for an example). It should be noted that 42 participants completed the CaTS for their first episode of self-harm (two participants could not remember this episode sufficiently and one misunderstood the task) and 44 participants completed the CaTS for their most recent episode of self-harm (one participant did not want to do the task for a second time).

Participants were also asked to rate their current emotional state (“How are you feeling?”) on a visual analogue scale (VAS) at the start and end of the session. It should be noted that the card sort task was completed after participants took part in a semi-structured interview about self-harm (reported elsewhere). The VAS was presented with numerical response options between 0 (worst possible emotional state, illustrated with a sad face) and 10 (best possible emotional state, illustrated with a happy face), with a neutral face (not sad or happy) at the midpoint of the scale. This was used to gauge whether participants experienced a change in well-being by taking part in the research (Biddle et al., 2013).



Fig. 1. The Card Sort Task for Self-harm (CaTS).

3. Results

3.1. Participants

Forty-five participants were recruited, aged between 13 and 21 years (mean age of 17). The sample included 39 females and 6 males. Most participants (53.3%) were recruited in the community via a user-led support service, schools, community groups and adverts on social media. We recruited 33.3% via Child and Adolescent Mental Health Services and 13.3% via Children's Social Care. Most participants (78%) reported their ethnic group as White British. The majority (53.3%) were in further education (6th form and college), followed by secondary school (26.6%), higher education (13.3%), with 6.6% were no longer in education. Participants were recruited as part of a research project that targeted looked-after young people (who are in the care of the state), thus 24 (53.3%) participants had experience of being in residential or foster care.

3.2. Frequency of self-harm

All participants had repeated self-harm, and had also self-harmed in the last 6 months at the time of recruitment. The age of first episode of self-harm ranged from 7 to 16 years; with an average of four years since the onset of self-harm. When asked about frequency of self-harm behaviour only 20% could specify a precise number of episodes and these ranged from two to 21. The remaining participants described rates over time best characterised as periods of high frequency (daily) and low frequency (not for two months).

3.3. Method of self-harm

Cutting was the most commonly reported method of self-harm, followed by overdose. The percentage of participants reporting various methods of self-harm are given in Table 1.

3.4. Sequence analysis

Describing the frequency of the occurrence of items/events in the dataset is an obvious but important first step in sequence analysis (Bakeman and Gottman, 1997; Sharpe and Koperwas, 2003). We selected 14 high frequency cards for the first episode and 15 for the most recent episode of self-harm, to include as individual items in the sequence analysis (Table 2). The remaining

Table 1
Self-harm methods reported by participants.

Self-harm method (ever used)	Percentage (frequency)
Intentional cutting	91.1% (41)
Overdose	60.0% (27)
Scratching yourself	44.4% (20)
Punching yourself or a wall/window	33.3% (15)
Banging your head	31.1% (14)
Burning yourself	31.1% (14)
Biting yourself	24.4% (11)
Preventing wounds from healing	22.2% (10)
Sticking sharp objects into yourself	20.0% (9)
Pulling out your hair	15.5% (7)
Rubbing glass on to your skin	11.1% (5)
Poisoning yourself	11.1% (5)
Other	28.9% (13)

Other self-harm methods include ligatures, self-strangulation, hanging, suffocation, friction burns, banging wrists together, pinching, pulling nails off, self-bruising, snapping elastic band on wrist, hitting self with objects, eating disorder, running out in front of cars, drinking too much, putting self into dangerous situations, drugs, smoking, fights, and risky behaviour.

Table 2
High frequency items for first and most recent episodes of self-harm.

First episode of self-harm Card/item	Frequency	Most recent episode of self-harm Card/item	Frequency
I felt depressed and sad	32	I felt depressed and sad	38
I could not tell anyone how I was feeling	30	I could not tell anyone how I was feeling	31
I hated myself	28	I isolated myself from others	31
I isolated myself from others	28	I hated myself	29
I felt worthless	24	I felt like a burden on people ^b	29
I was not able to sleep	24	I felt I could not escape from feelings or situations	28
I could not trust anyone ^a	23	I felt worthless	27
I was angry	23	I felt very hopeless about the future ^b	26
I felt better after self-harm ^a	23	I was not able to sleep	26
I felt I could not escape from feelings or situations	22	I had access to the means to hurt myself	26
I had access to the means to hurt myself	22	I felt very anxious	25
I did it on impulse without planning	22	I was angry	24
I could not think of anything else to do ^a	21	I did it on impulse without planning	24
I felt very anxious	20	I wanted to die ^b	23
		I was very agitated and restless ^b	23

^a High frequency item reaching criterion for first episode of self-harm only.

^b High frequency item reaching criterion for most recent episode of self-harm only. (Other items reached criterion for both episodes.)

cards were divided into low frequency (LF) (those with a count of nine or less) and medium frequency (MF) (count of 10–20 for first episode and 10–22 for most recent episode). These cut-offs were determined by identifying distinctive changes in the gradient of the slope of the card frequencies using a diagram rather like a scree plot used in Exploratory Factor Analysis (Ferguson and Cox, 1993). In Factor Analytic studies researchers visually assess a plot of eigenvalues associated with a given component to determine which factors explain most variability in the data – the ideal pattern for this procedure being a steep curve. Here we visually assessed the slope of plots of card frequencies to determine cut-off points. It was necessary to limit the number of items included in the sequence analysis to ensure the number of cells in the transitional frequency matrix was manageable and that the data could be clearly described in a state transition diagram (Bakeman and Gottman, 1997). This allowed us to produce “frequency filtered” card sequences with a manageable numbers of items coded – an approach used in previous sequence analysis studies (DeBoard Marion et al., 2003). The frequencies for all items are given in the supplementary material (Table S2 and S3).

The mean number of cards used to describe first episode of self-harm was 27 (range=2–59) and 29 for the most recent episode (range=4–63). We also examined the number of cards used at each time point. For both episodes the number of cards selected peaked at one-hour before self-harm (Fig. 2). We note that the items used for this time-stamp were largely negative emotions

(see Table S4). In contrast negative emotions feature less at the 6 month time stamp where life events dominated.

Eleven of the high frequency items were the same for both first and most recent episodes (see Tables S2 and S3 for high-frequency items specific to first or most recent episode). The high frequency items plus “medium frequency” and “low frequency” items were used in the frequency filtered sequence analysis, along with “6 months before” and “I self-harmed” (indicating the beginning and end of sequences).

3.5. First episode of self-harm sequence analysis

The first episode and most recent episode sequences were analysed using lag sequence analysis. This involved determining the frequency of each possible discrete two-card sequence (antecedent – sequitur pairing) in the frequency filtered sequences, for example, how often did (“I felt very anxious”) occur after (“I could not trust anyone”). These card pairing frequencies were then tabulated in a transition frequency matrix; a two-way contingency table with antecedent cards (lag 0) in rows and sequitur cards (lag 1) in columns. A chi-squared analysis was used as a statistical test of cross-dependency and standardised normal residuals (SNR) were used to identify which two-item transitions contributed disproportionately/more strongly to the sequential structure (Bakeman and Gottman, 1997). Individual transitions are of interest when their contribution (i.e. SNRs) reaches a criterion value thus indicating significant interdependence between two factors. A threshold value of > 2.0 was chosen so that the most important transitions could be clearly represented in a state transition diagram, although less stringent criterion values have been recommended (Colgan and Smith, 1978). In the state transition diagrams arrows represent links between two items ($A \rightarrow B$) which reached the critical value, representing two factors which are perceived as sequentially related, that is, B followed A more frequently than would be expected if no sequential pattern existed in the data (Bakeman and Gottman, 1997). Transitions with larger SNRs are indicated by wider arrows. In some cases longer strings of items appear in a state transition diagram eg. $A \rightarrow B \rightarrow C$ and here it is tempting to assume that the higher order three-item sequence also holds. However, in order to test such higher order relationships larger samples are required and so we have focused on two-item associations (hence we can say that the relationships $A \rightarrow B$ and $B \rightarrow C$ hold true, but not A through B to C). This is an established approach in the sequence literature (Bakeman and Gottman,

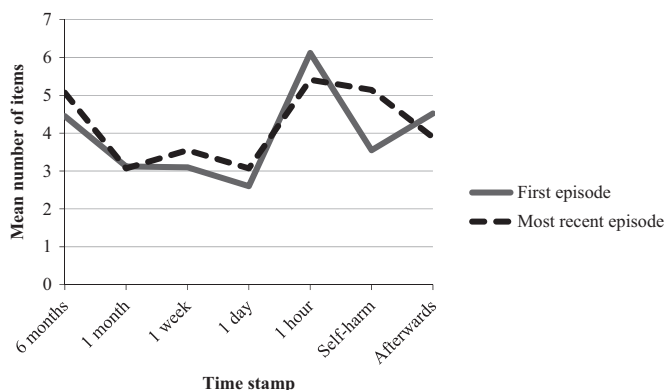
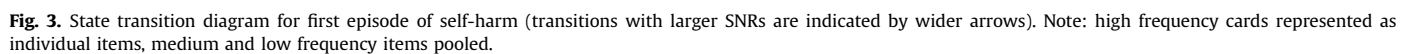


Fig. 2. Mean number of items used at each time stamp (first episode versus most recent).



For the first episode of self-harm, a chi square test indicated that the observed frequency of two-factor transitions was significantly different to that expected by chance: $\chi^2(289) = 733.64$, $p < .001$. Thus, there was a significant (non-random) sequential structure in the transitional frequency matrix. The significant SNRs are given in [Table S5](#) with these transitions represented in a state transition diagram in [Fig. 3](#).

A number of notable transitions occurred between different negative feelings, suggesting that the first episode of self-harm is preceded by a pattern of very difficult emotions. A behavioural transition occurred between not being able to sleep and isolating the self. There are also transitions between having no one to trust and having no one to tell, and in feeling better immediately after self-harm. Medium and low frequency items occur as single items in the diagram and have associations with a number of other items, indicating heterogeneity in the nature of the transitions leading to the first episode of self-harm. Medium frequency items follow the six-month start point, indicating variation in factors that are more distal to the first episode of self-harm.

A transitional frequency matrix was created for the most recent episode (frequency filtered) card sequences. A chi square test

As with the first episode of self-harm, the only item to directly precede the most recent episode of self-harm was "I did it on impulse without planning". Interestingly, in contrast to the first episode analysis, self-hate now emerges immediately proximal to impulsivity, along with access to means. A pattern of negative emotions associated with self-harm was observed similar to the first ever episode, however, self-hate was now associated with worthlessness, which in turn was associated with hopelessness (which notably was absent in the first ever episode).

3.7. Emotional state VAS

The mean score on the emotional state VAS at the start of the session was 6.60 ($SD=2.04$), and at the end of the session was 6.69 ($SD=1.90$), $t(44) = -.47$, $p = .640$, suggesting that the participants did not experience a significant change in their emotional state having completed the task. Note that the scores were at the positive end of the scale.

episode and the most recent episode of self-harm, there were some notable differences. Of particular concern was the finding that 'feeling better after self-harm' was used frequently in relation to first ever self-harm episodes, but not the most recent episode. Wanting to die and hopelessness were reported frequently in relation to most recent episodes of self-harm, but not the first episode. This describes a pattern of deterioration over time, whereby self-harm may have given relief early on for negative emotions and thoughts, but this functionality disappears over time and hopelessness and suicidal intent emerge. This fits with Joiner's notion of acquired capability espoused in his Interpersonal Theory of Suicidal Behaviour (eg. Joiner et al., 2009) where repeated self-harm dampens any fear associated with lethal acts. Further research on this issue is crucial given the recent systematic review by Edmondson et al. (2016) highlighting self-harm as a 'positive' experience (from first-hand accounts). Our findings also indicate that it is important to acknowledge that self-harmful behaviour is not static, instead it develops and evolves over time. A young person may begin self-harming without suicidal intent but this may emerge in later episodes. Thus, clinicians and others working with young people who self-harm should not make assumptions on intent and risk solely based on history rather than on regular monitoring and re-assessment.

The CaTS also permits the participant to build a picture of their own personal experience of self-harm from a wide array of possible influences. This is important and we note that a number of issues that have been reported recently in the literature do not feature with high frequency here such as the influence of social media (Daine et al., 2013).

4.1. Strengths and limitations

We have developed a novel, systematic method to investigate the key relationships between potential thoughts, feelings, events and behaviours associated with self-harm which describes sequential patterns over time. The method is easy to administer and flexible so that it can be used in a variety of settings to address different research questions. Although we have focused on young people the method can be easily used in other groups. Indeed, the sample studied here was predominately female which reflects prevalence of self-harm in both hospital (Bergen et al., 2010) and community (O'Connor et al., 2009) settings. However, in future studies using the CaTS it will be important to compare sequences generated by males and females given that males have a higher risk of dying by suicide after self-harm compared to females (Hawton et al., 2015).

In future, the CaTS could be used in clinical practice prospectively to map patterns and changes in self-harm over time. In weekly therapeutic sessions the CaTS time stamps could be altered to reflect the days/hours in the preceding week where a self-harm episode had occurred. This could have therapeutic value for supporting both client and therapist in understanding the process, and meaning of self-harm, and how this may change with therapeutic intervention. Anecdotally, young people really enjoyed doing the CaTS and reported it had given them new insights into their journey into self-harm.

Many clinicians feel that dealing with a client who is self-harming/suicidal is one of the greatest clinical challenges that they face (Slee et al., 2007). Starting a conversation about self-harm/suicidality and the psychological distress associated with these behaviours can be daunting for even the most experienced clinician. Encouraging clients to complete the CaTS at the start of a therapeutic session could help facilitate this conversation.

Given a larger sample size it would be interesting to examine differences in sequences generated between genders and different types of self-harm, and to examine factors that are protective

against, or delay, repeated self-harm. As previously noted, larger sample sizes would allow us to examine longer chains of transitions between factors and explore differences in sequences in those with many years of self-harm compared to those who have just begun self-harming. With larger sample sizes the CaTS and sequence analysis also have the potential to investigate at what point people stop feeling better after self-harm and instead begin to feel suicidal and hopeless. This is important information for timing of appropriate interventions. Larger studies could also investigate the impact of imposing different cut-off points for frequency analysis and conduct sensitivity analyses to evaluate these.

For the most recent episode of self-harm, young people were describing an event that occurred recently (within the last six months), which should be relatively easy to recall. However, for the first ever episode we asked participants to recall an event that happened years ago. Nonetheless, the first time someone engages in self-harm is likely to be a particularly salient memory. Indeed, qualitative research demonstrates that people can recall rich and detailed information about previous self-harm (Sinclair and Green, 2005; Wadman et al., 2016). Nonetheless, in future research using the CaTS it will be important to compare our results with those with a recent first episode of self-harm.

5. Conclusions

The CaTS and use of sequence analysis offers a systematic approach to understanding the dynamic interplay of factors that lead to self-harm in young people. It allows young people to describe their own personal journey into self-harm – indeed many reported enjoying doing the CaTS. The approach offers a method to target key points for intervention in the self-harm pathway. Crucially the factors most proximal to self-harm (negative emotions, impulsivity and access to means) are modifiable with existing interventions. Future research efforts should be targeted at using this approach in different populations, in clinical practice and in larger samples. The CaTS could also be used as a predictive tool in prospective research applying logistic/polynomial regression analyses or log-linear approaches. Finally, the CaTS could be modified to examine different behaviours such as binge-drinking, substance misuse/abuse and binge-eating.

Conflicts of interest

None.

Contributors

All authors contributed to the design of the study, the interpretation of results and article preparation. All authors have approved the final article.

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worked with us to recruit young people to the study.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at <http://dx.doi.org/10.1016/j.jad.2016.07.004>.

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